National Energy Board

Office national de l'énergie

Short-term **Natural Gas** Deliverability *from the* **W**estern **C**anada **S**edimentary **B**asin *2002-2004*

An **ENERGY MARKET ASSESSMENT** • December 2002

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Acronyms

B.C.	British Columbia
ABM	Coal Bed Methane
EMA	Energy Market Assessment
MBP	Market Based Procedures
NEB	National Energy Board
NGMA	Natural Gas Market Assessment
NE	North East
NW	North West
PSAC	Petroleum Services Association of Canada
SE	South East
SW	South West
WC	West-Central
WCSB	Western Canada Sedimentary Basin

Units

Prefix	Multiple	Symbol
kilo-	10^3	k
mega-	10^6	M
giga-	10^9	G
tera-	10^{12}	T
peta-	10^{15}	P
exa-	10^{18}	E

m^3/d	= cubic metres per day
Mcf	= thousand cubic feet
MMcf	= million cubic feet
Bcf	= billion cubic feet
Tcf	= trillion cubic feet
Mcf/d	= thousand cubic feet per day
MMcf/d	= million cubic feet per day
Bcf/d	= billion cubic feet per day
GJ	= Gigajoules (10^9 joules)

FOREWORD

As part of its regulatory mandate, the National Energy Board (NEB or the Board) continually monitors the supply of all energy commodities in Canada (including electricity, oil, natural gas and natural gas liquids) and the demand for Canadian energy commodities in both domestic and export markets.

In 1987, the Board adopted the Market-Based Procedure (MBP) for assessing applications for long-term natural gas export licences. The MBP is based on the premise that the marketplace will generally operate such that Canadian requirements for natural gas will be met at fair market prices. The MBP consists of a public hearing component and a monitoring component.

The monitoring component of the MBP involves an ongoing assessment of Canadian energy markets and facilitates the publication of *Canadian Energy Supply and Demand* reports as well as a series of *Natural Gas Market Assessment* (NGMA) reports. As a result of the increasing level of integration within energy markets, the Board expanded its energy market monitoring program in the late 1990s to include studies related to all major energy commodities. The enhanced monitoring program led to the development of *Energy Market Assessments* (EMAs) and, to date, EMAs on natural gas, natural gas liquids, oil and electricity have been published.

This EMA report, titled *Short-term Natural Gas Deliverability from the Western Canada Sedimentary Basin, 2002-2004*, examines the factors which affect gas supply in the short-term and presents an outlook for deliverability to the year 2004. The main objective of this report is to advance the understanding of the short-term gas supply situation by examining recent trends in the production characteristics of the Western Canada Sedimentary Basin (WCSB) and applying these trends to provide an outlook for short-term deliverability from the WCSB. Further, this report is an update to the Board's December 2000 EMA, titled *Short-term Natural Gas Deliverability from the Western Canada Sedimentary Basin, 2000-2002* (An Energy Market Assessment - December 2000).

During the preparation of this report, a series of meetings and discussions were conducted with natural gas producers, pipeline companies, industry associations and government agencies. The NEB appreciates the information and comments it received.

OVERVIEW

In its December 2000 EMA, the Board stated that the initial productivity of a typical gas well in the WCSB has been decreasing and that decline rates have been increasing since 1996. Because of these changing characteristics, the number of wells placed on production each year would have to increase in order to increase deliverability from the WCSB. In the December 2000 EMA, the Board anticipated that the number of gas wells drilled in 2002 would be about 40 percent higher than in 1999. This increased activity was expected to increase deliverability from 465 million m^3/d (16.4 Bcf/d) in 1999, to 490 m^3/d (17.2 Bcf/d) in 2001 and to 495 million m^3/d (17.5 Bcf/d) in 2002. Actual increases in drilling activity have been slightly higher than anticipated but the deliverability response has been lower than expected. The WCSB was producing 470 million m^3/d (16.6 Bcf/d) at the end of 2001.

In this assessment of deliverability, the Board has examined the same data plus two additional years of production information using the same general methodology as in the December 2000 assessment. **This examination indicates that decreasing initial productivity per connection and increasing decline rates, which started in 1996, have continued into 2000. However, production data for 2001 connections indicate that initial productivities and decline rates appear to be stabilizing at the 2000 rates**. The continuing change in the producing characteristics of a typical connection means that substantially more connections are required today than in 1996 to maintain deliverability.

Driven by high oil and gas prices in late 2000 and early 2001, industry increased drilling activity in 2001 and drilled 11,200 gas wells. Lower gas prices in late 2001 and early 2002 led to reduced activity and many industry associations are now estimating that about 9,000 and 10,000 gas wells will be drilled in 2002 and 2003 respectively. Because of multiple productive horizons within a single well bore, the Board estimates that this drilling activity will yield about 11,000 and 11,500 connections in 2002 and 2003 respectively. The Board also anticipates that drilling activity will continue to increase in response to increasing demand and this will result in about 12,000 connections in 2004. However, this high activity will not offset the effect of lower initial productivity per connection. Based on these trends, **the Board expects deliverability to decrease from 470 million m^3/d (16.6 Bcf/d) in late 2001 to 450 million m^3/d (15.9 Bcf/d) by the end of 2004**.

The Board would also like to point out that this outlook deals only with the WCSB and does not represent total Canadian deliverability. In addition, the outlook is also restricted to conventional supplies; it does not consider the potential for development of Coal Bed Methane (CBM) or tight gas and does not include withdrawals from storage reservoirs.

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INTRODUCTION

In its previous assessment of short-term natural gas deliverability, the NEB stated that deliverability from the WCSB would gradually increase from about 465 million m³/d (16.4 Bcf/d) at the beginning of 2000, to 490 million m³/d (17.2 Bcf/d) by end of 2001 and to 495 million m³/d (17.5 Bcf/d) by the end of 2002, based on a 40 percent increase in drilling activity. The increase in drilling activity has been slightly higher than anticipated; however, deliverability has not increased as rapidly as expected, averaging about 470 million m³/d (16.6 Bcf/d) in late 2001.

This EMA updates the Board's assessment of short-term deliverability using the same general methodology as in the December 2000 assessment[1]. Chapter 2 contains an historical review of natural gas production and drilling activity for the WCSB. Chapter 3 describes the analysis of historical production and provides analytical results in terms of initial productivity and production decline rates of a typical connection. Chapter 4 briefly describes the methodology used to determine future deliverability and presents an outlook from 2002 to 2004 based on expected drilling activity and resulting connections. Chapter 5 summarizes the key conclusions.

1 Reader is referred to December 2000 EMA for more detailed description of historical data analysis and forecasting techniques than provided in this EMA.

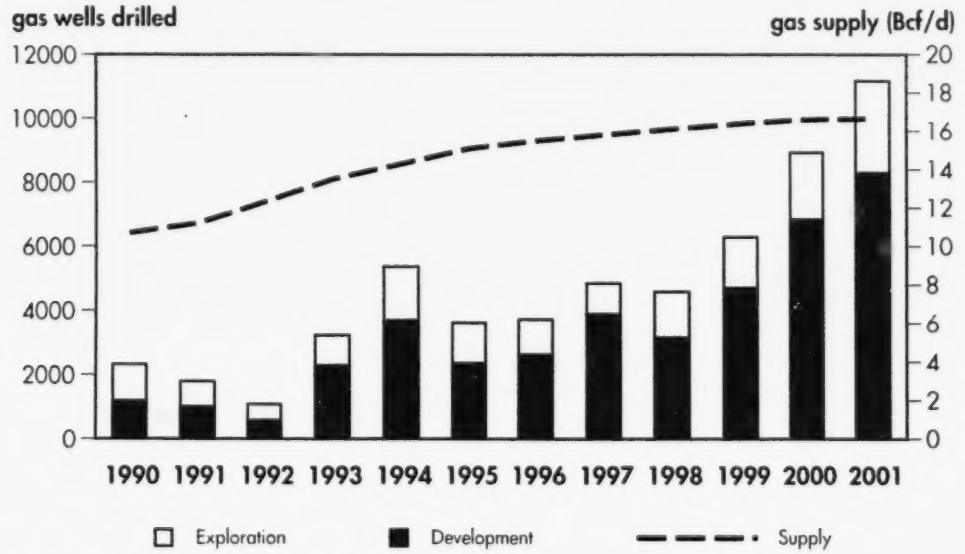
Historical Production and Drilling Activity

Average WCSB natural gas production increased from about 300 million m³/d (10.6 Bcf/d) in 1990 to about 465 million m³/d (16.4 Bcf/d) in 1999. Increases in production have been modest since 1999, reaching 470 million m³/d (16.6 Bcf/d) in 2001. These production rates were attained by connecting an increasing number of new wells over the last decade pointing to a trend of diminishing returns to increasing drilling activity (Figure 2.1). This chapter discusses natural gas production, drilling activity and connections for the period 1990 to 2001.

2.1 WCSB Gas Areas

The WCSB includes most of Alberta, significant portions of British Columbia and Saskatchewan, as well as parts of Manitoba and the Northwest Territories. Within this vast area, the topography and geology vary significantly, influencing the exploration and development strategies of the gas industry. For example, physical access to lands for drilling is essentially unrestricted in the southeastern part of the basin, which tends to be flat prairie, while in the western part of the basin, adjacent to the Rocky

WCSB Gas Supply Response



Sources: Nickles Daily Oil Bulletin and Geoscout for Windows

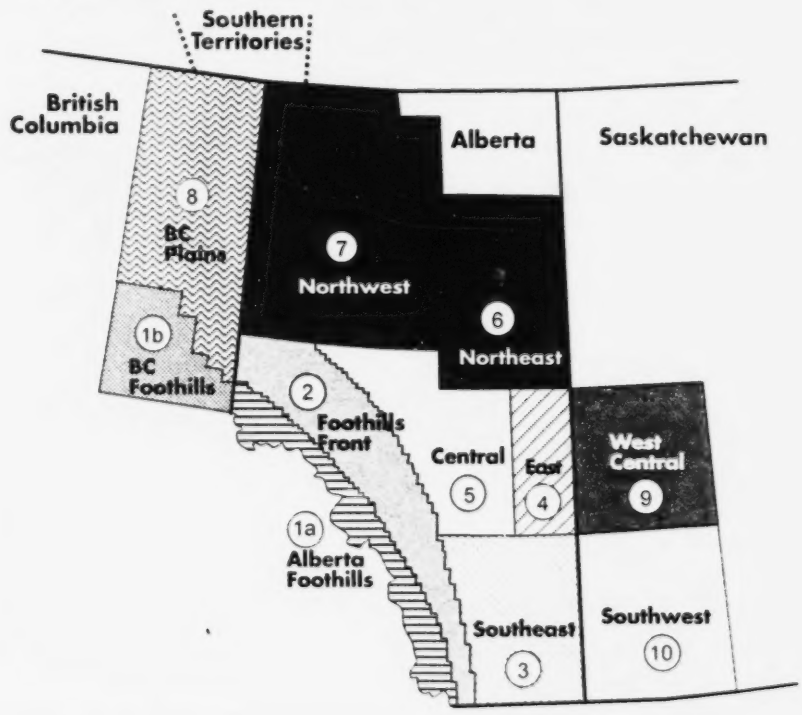
Mountains, access is more difficult. Toward the northern end of the basin, areas are often covered with muskeg, so drilling has to be carried out in winter when the ground is frozen. In addition, there tend to be more restricted areas for environmental reasons in the western portion of the basin. As a result, the investment needed to drill a well varies with the topographical characteristics and environmental restrictions of the location. Generally, limitations to access increase the cost and reduce the amount of drilling and development.

Regional geology can also have a great impact on drilling and costs. Geological formations in the WCSB dip to the southwest resulting in increasing drilling depths and increasing drilling complexity from east to west. Together, these differences in physical access and depths result in very large differences in drilling costs across the WCSB. To illustrate, a shallow well in southeastern Alberta or southwestern Saskatchewan may cost less than $100,000 whereas a deep well in the Foothills may cost more than $10 million.

Gas recovery and productivity per well also tend to vary according to area. The shallow wells in southeastern Alberta and southwestern Saskatchewan generally have initial productivity rates of six thousand m /d (0.2 MMcf/d). In contrast, some deep wells in the Foothills exhibit initial productivity rates of 600 thousand m /d (21 MMcf/d).

The large regional differences in physical characteristics within the WCSB require that the basin be subdivided into smaller areas with similar characteristics for production decline analysis. For this report, the WCSB has been subdivided into gas producing areas following some of the designations developed by the Petroleum Services Association of Canada (PSAC). In addition, PSAC's Foothills area was further subdivided by province (1a - Alberta Foothills and 1b - B.C. Foothills). Finally, this study added the southern Territories for a total of 12 areas (Figure 2.2). Each of these areas was

WCSB Gas Areas



analysed independently and individual deliverability outlooks were generated for each area. Any information presented for a larger area, such as the entire WCSB, is derived by summing the results of the individual areas.

2.2 Historical Production

Total marketable gas production from the WCSB has increased from approximately 300 million m³/d (10.6 Bcf/d) in 1990 to over 470 million m³/d (16.6 Bcf/d) in 2001. Contributions to this growth in production have varied substantially by geographical area and by the year wells were placed on production (connection year).

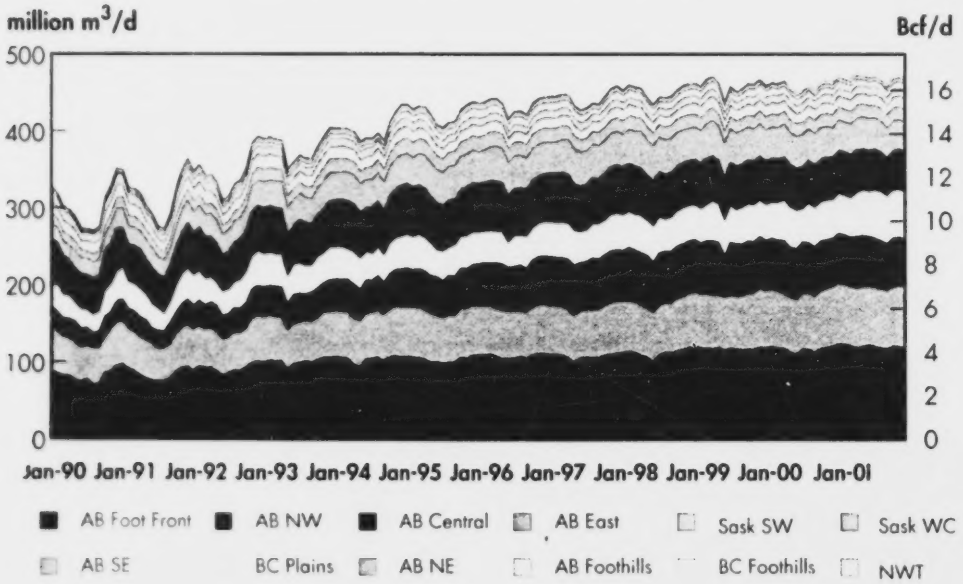
2.2.1 *Production by Geographical Area*

Alberta provided about 81 percent of the gas production from the WCSB in 2001, with the remainder provided by British Columbia (15 percent), Saskatchewan (three percent) and one percent from the Northwest Territories. As noted in section 2.1, producing characteristics vary significantly by region. The contribution to total WCSB production of each geographical area is shown in Figure 2.3 in the order of their 2001 production rates.

On a regional basis, about 70 percent of the gas production from the WCSB in 2001 was provided by the first four areas shown in Figure 2.3. These four areas are producing at increasing rates while the remaining eight areas are producing at either stable or decreasing rates. Although not the top producing area, the B.C. Plains has experienced steady growth, with a significant production increase in 2001 as a result of the startup of the highly productive Ladyfern field.

It is also interesting to examine the geographical areas in terms of cost of drilling per well. The shallow producing reservoirs with a low cost per well are located on the eastern side of the basin in

WCSB Marketable Gas Production by Geographical Area



Saskatchewan West Central and South West, and in Alberta South East, East and North East. In 2001 these areas provided about 32 percent of WCSB production. The medium cost areas, which are defined as Alberta Central, Alberta North West and B.C. Plains, contribute 37 percent of WCSB production. Producing reservoirs in the western areas of the basin tend to be larger and more productive but fewer wells are drilled in these areas because of high cost and higher risk. The Foothills Front area, and the Alberta and B.C. Foothills areas account for 26 and five percent respectively of WCSB production.

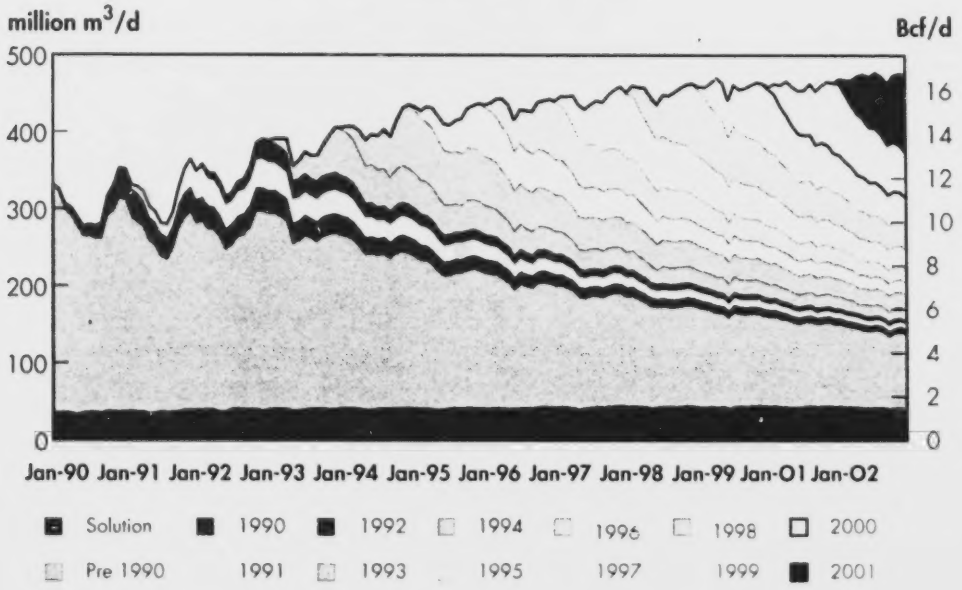
2.2.2 Production by Connection Year

Figure 2.4 shows marketable natural gas production grouped according to the year that individual geological horizons within a well bore were placed on production or, in other words, their connection year. Grouping by connection year shows total production as well as the changes in production characteristics over time. It also demonstrates the importance that drilling activity and the resulting connections have on deliverability. For example, 50 percent of production in December 2001 was provided from geological horizons connected in 1997 or later. Also, the significantly steeper slopes for recent connections suggests this production is declining at higher rates than from older connections. The significant swings in total production from 1990 to 1994 also indicate that producing reservoirs were not always producing at capacity and were being utilized to match swings in seasonal demand. Storage capacity was expanded after 1994 and this has allowed the WCSB to produce at capacity without significant seasonal swings.

2.3 Drilling Activity and Gas Well Connections

Estimates of gas wells, gas well completions and connections in the WCSB are available through various publications. These estimates are often used as an indicator of industry activity and future production. Various terms with different meanings are used interchangeably, which may result in

WCSB Marketable Gas Production by Connection Year

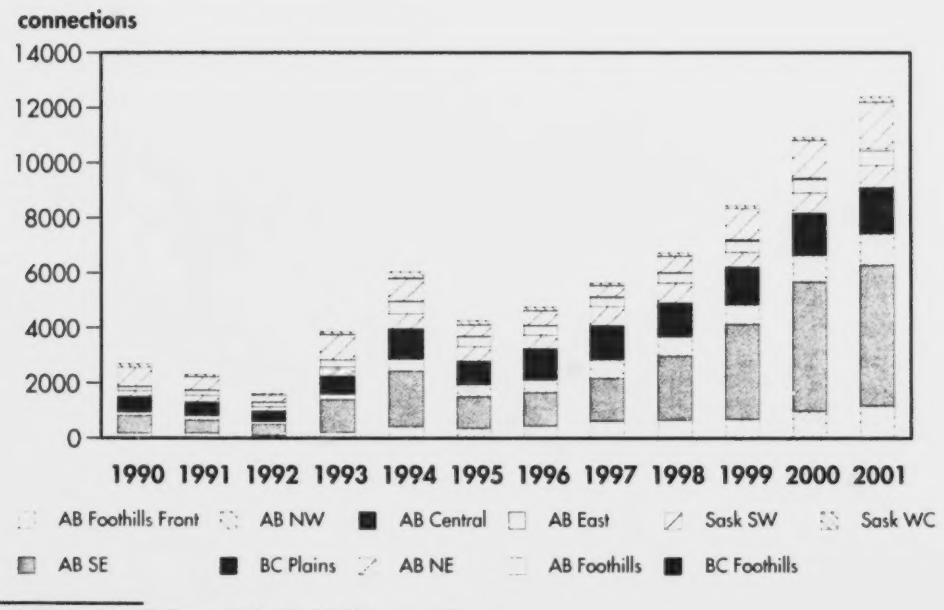


different estimates of drilling activity. In this report, the term gas well refers to the values reported by the Daily Oil Bulletin[1] and these generally represent well bores; each of which may contain one or more geological horizons capable of producing natural gas.

The determination of future deliverability and analysis of historical production supporting deliverability outlooks, deals with connections rather than wells. A connection refers to each geological horizon within a gas well having any amount of natural gas production without any time restriction being imposed; that is, even horizons with only one month of natural gas production are considered to be a connection. The difference between the number of connections and gas wells will vary from year to year and from area to area. For example, the number of gas connections in the WCSB exceeded gas wells by 30 percent from 1997 to 2000 and by 11 percent in 2001, which is considered a year of record drilling activity. Generally, the number of connections increases with the number of wells drilled but a precise relationship could not be established due to various factors such as the time lag that occurs between drilling and connecting a well. The Board has relied heavily on the results of 2000 and 2001 to establish the number of connections which will result from the expected increases in drilling activity in 2003 and 2004.

Drilling activity is often discussed in terms of overall wells. However, because of substantially different well costs and productivity across the WCSB, comparisons of activity and production are better when restricted to small geographic areas. Therefore, to facilitate the comparisons of production and connections by geographical area, connections shown in Figure 2.5 are plotted in the same order as production rates in Figure 2.3. Figure 2.5 shows a large increase in connections over the last decade and also shows that the majority of them are located in the low cost, shallow gas areas located on the eastern side of the WCSB. These areas account for 67 percent of connections in 2001, but because of low productivity per well, only represent 32 percent of WCSB production. On the other hand, the remaining areas of the basin with higher well costs and productivities only account for 33 percent of the connections, but contribute 68 percent of WCSB production.

WCSB Gas Well Connections by Year



1 *Nickle's Daily Oil Bulletin* published by Nickle's energy Group.

PRODUCING CHARACTERISTICS

As noted in the previous chapter, productivity per connection varies significantly across the WCSB. Historical data also suggests that production from recent connections is declining at much higher rates than from older connections. This chapter briefly describes the analytical techniques applied to historical production to assess any change in producing characteristics over time for each geographical area within the WCSB.

3.1 Decline Analysis Methodology

The techniques used to analyze historical production are generally the same as those used in the Board's December 2000 EMA, except that connections were used rather than successful wells. For a group of connections, this type of analysis provides the initial productivity of a typical connection in the group. The analysis also provides the decline rate occurring during the first two years of production and the following decline rate occurring over the remaining producing life of a typical connection within the group. Each geographical area was analyzed in this fashion. These three parameters can be utilized with an exponential equation to duplicate the production profile of each typical connection.

3.2 Initial Productivity Trends in the WCSB

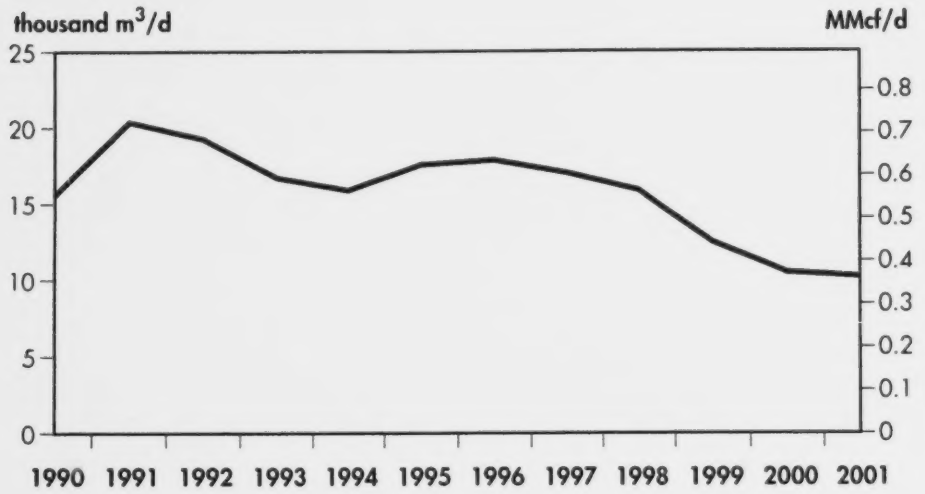
The Board's analysis of initial productivity was performed for each geographical area. However, for illustrative purposes, only average values of initial productivity per connection for the entire WCSB are provided for each connection year (Figure 3.1). It should be noted that the initial productivities presented in this report are based on *connections* and should not be compared to initial productivities based on *successful wells* (geological zones still producing one year after commencement of production) in the December 2000 EMA. In this assessment, connections rather than successful wells have also been used for determining future deliverability. Furthermore, average productivities shown in Figure 3.1 exclude connections from the very high productivity Ladyfern field, placed on production in 2001. Ladyfern is considered to have unique producing characteristics and was analysed as an additional area.

The much lower average productivity for the WCSB for recent connections reflects a decline in producing capability of individual connections as well as an increasing proportion of connections in lower productivity areas such as southeastern Alberta.

3.3 Production Decline Trends in the WCSB

The decline rates resulting from the decline analysis performed by the Board are based on representing a declining production profile by an exponential equation with initial productivity and

Average Initial Productivity per Connection by Connection



nominal decline rate as variables. The same production profile can also be represented by a constant percent equation having initial productivity and *effective decline*[3] as variables. The difference between nominal decline rate and effective rate is small at low rates but the difference increases at higher rates. For the benefit of those wishing to compare nominal decline rates listed in this report to others using effective decline, nominal decline rates of 10, 20, 30, 40 and 50 percent convert to effective decline rates of 9.5, 18.1, 25.9, 33.0, and 39.3 respectively.

Decline analysis was performed for each individual area, but for illustrative purposes, only the average nominal decline rates by connection year for the WCSB are provided (Figure 3.2). This analysis shows that production from recent connections declines faster than from older connections. The initial decline rate during the first two years of production has reached 50 percent. The second decline rate, in the remaining producing life of the connection, has reached 28 percent. The increasing average decline rate for the WCSB reflects increasing decline rates for individual connections as well as a shift in activity towards shallow gas in southeastern Alberta where connections exhibit very high initial decline rates in their first year of production.

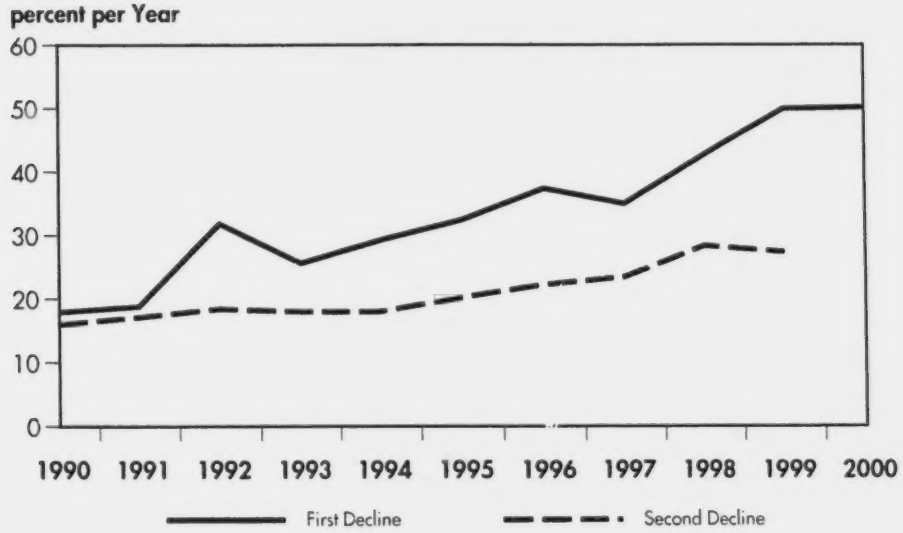
An estimate of the overall decline rate for the WCSB can be determined by extrapolating the decline rates for each connection year. Production from current connections in the WCSB is declining at an average rate of 20 percent per year, a rate which is influenced by a large number of older connections that are declining at lower rates. Based on this overall decline rate, approximately 85 million m^3/d (3 Bcf/d) of new production must be added in each year to offset declines in existing production.

3.4 Producing Characteristics for Typical Connection by Area

Figure 3.1 indicates that initial productivities for 2000 and 2001 connections are similar. This suggests that the trend of ever decreasing initial productivities may be subsiding. Figure 3.2 suggests that stabilization of decline rates may also be occurring. For the purpose of calculating future

1 Defined in Glossary under Decline Rate.

WCSB Average Decline Rates by connection Year



deliverability, it is assumed that connections in the next few years will have the same producing characteristics as recent connections (Table 3.1).

The amount of gas recovered by a typical connection over its producing life is dependent on the combination of its initial productivity and the rate at which production declines after it is placed on production. The decreases in initial productivity and the increases in decline rates mean that a recent typical connection in a geographical area only recovers 25 to 50 percent as much gas as a 1995 connection. The tendencies toward drilling in low cost areas, characterized by low productivities per connection, result in even lower average productivities for the WCSB. An average 2001 connection will recover less than 25 percent of the average 1995 connection. These large reductions in gas recoveries per connection correlate with the diminishing gas supply response to increasing drilling activity discussed in Chapter 2. Detailed analysis to determine the causes of the reductions in gas recovery per connection is beyond the scope of this study.

Production Characteristics for Typical Connections

		First Decline Rate	Start of Second Decline	Second Decline Rate	Initial Productivity	
Province	**Area**	**%**	**Months**	**%**	**$10^3m^3/d$**	**MMcf/d**
Alberta	Foothills	40	24	18	50.0	1.75
	FH Front	48	24	26	28.0	1.00
	SE	60	16	26	5.1	0.18
	East	60	15	28	8.5	0.30
	Central	60	18	30	11.3	0.40
	NE	27	24	19	7.4	0.26
	NW	42	24	34	17.0	0.60
B.C.	Plains*	36	18	20	25.5	0.90
	Foothills	36	24	24	311.0	11.00
Sask.	WC	41	30	30	7.1	0.25
	SW	52	18	24	2.0	0.07

* excludes Ladyfern wells.

DELIVERABILITY OUTLOOKS

This chapter contains a deliverability outlook to the end of 2004.

4.1 Future Deliverability

Future natural gas deliverability from gas well connections within a geographical area is a function of initial deliverability from existing connections, normal decline in deliverability from existing connections as depletion occurs, the number of new connections and the average deliverability of new connections. As a result, future deliverability from gas well connections can be expressed, in general terms, by the following equation:

Future deliverability = [deliverability from existing connections - decline] + [production profile of a typical new connection multiplied by number of new connections]

In making its determination of future deliverability from gas well connections, the Board has used this framework.

Another component of deliverability is gas production from oil wells, termed *solution gas*. This gas is produced as a by-product of oil production. Solution gas production accounts for about nine percent of overall WCSB production and has been consistent over many years; accordingly, this trend has been extrapolated to project future solution gas production from each geographic area.

The Southern Territories and the Ladyfern project have been excluded from the decline analysis. Deliverability for these areas is based on the assumption that production will decline from current levels at the rate which will recover assigned reserves.

The deliverability outlook for the WCSB is the sum of the individual areas.

4.2 Deliverability Outlook

Producers increased drilling effort substantially from 1996 to 2001, resulting in the number of gas well connections increasing from 4,800 to a record level of 12,400 in 2001. Since gas prices were lower in 2001 and early 2002, industry has reduced its drilling effort. Industry associations are forecasting that about 9,000 gas wells will be drilled in 2002 or about the same drilling rate as in 2000, which resulted in about 11,000 gas well connections. These associations are also forecasting that drilling activity will increase in 2003.

For this outlook, it was assumed that market conditions would be favourable for industry to maintain drilling activity in 2002 and increase activity in 2003. The Board projects that this drilling activity will

result in 11,000 connections in 2002 and 11,500 connections in 2003. Increasing North American demand will also encourage industry to further increase drilling activity in 2004 to reach the levels experienced in 2001. Consequently, the Board estimates the number of connections will increase to 12,000 in 2004. It also assumed that industry would not deviate from the strategy followed for the last few years. As a result, a major shift in activity from one area of the basin to another is not expected. Based on this projected activity, deliverability declines slightly from 470 million m^3/d (16.6 Bcf/d) at the end of 2001 to about 450 million m^3/d (15.9 Bcf/d) by the end of 2004. Table 4.1 provides December 2001 production rates and the Board's deliverability outlook for each geographical area. This outlook includes the deliverability from the existing high productivity Ladyfern area but does not consider potential deliverability from an additional discovery with similar producing characteristics. This type of discovery that is produced at high initial rates could offset the anticipated decline over the outlook period.

WCSB Deliverability Outlook

Year		Production		Year End Deliverability					
		Dec 2001		2002		2003		2004	
Province	Area	$10^6m^3/d$	MMcf/d	$10^6m^3/d$	MMcf/	$10^6m^3/d$	MMcf/	$10^6m^3/d$	MMcf/d
Alberta	Foothills	14.7	520	14.6	515	14.6	515	14.6	515
	FH Front	120.4	4 250	118.3	4 175	119.3	4 210	121.1	4 275
	SE	79.3	2 800	79.3	2 800	81.3	2 870	80.7	2 850
	East	17.6	620	16.3	575	15.6	550	15.6	550
	Central	51.0	1 800	46.5	1 640	45.0	1 590	45.3	1 600
	NE	35.7	1 260	33.1	1 170	30.2	1 065	27.8	980
	NW	62.3	2 200	56.4	1 990	53.7	1 900	53.5	1 890
B.C.	Foothills	7.8	275	11.3	400	11.3	400	11.3	400
	Plains*	49.6	1 750	53.5	1 890	53.6	1 890	56.4	1 990
	Ladyfer	11.3	400	11.3	400	6.4	225	4.2	150
Sask.	WC	5.1	180	5.0	175	4.8	170	4.8	170
	SW	11.0	390	11.0	390	11.0	390	11.3	400
NWT		4.2	150	4.0	140	3.5	125	3.3	115
WCSB		470.1	16 595	460.6	16 260	450.4	15 900	450.0	15 885

* Excludes Ladyfern

SUMMARY AND CONCLUSIONS

Despite drilling a record number of gas wells in 2001 and the start up of the highly productive Ladyfern project, increases in natural gas deliverability have been lower than projected in the Board's previous EMA. The lower than expected performance was the result of the continuation of trends in producing characteristics, identified in the previous assessment, at higher rates of change than previously anticipated. That is, decreasing initial productivity per connection and increasing decline rates, which started in 1996, have continued into 2000. This reflects the declining producing capability of recent connections in most areas of the WCSB as well as the increasing proportion of connections in lower productivity areas such as southeast Alberta. However, the analysis of recently connected wells indicates that initial productivities for 2001 connections are stabilizing at 2000 rates and decline rates also appear to be stabilizing.

Initial productivity and the rate of decline each influence the amount of gas recovered per connection and the resulting deliverability. For example, gas recovery from recent connections will be from 25 to 50 percent of the gas recovery from 1995 connections. The tendencies toward drilling in shallow gas areas characterized by low productivities per connection result in even lower average productivities for the WCSB. An average gas recovery for 2001 connections will be less than 25 percent of the average gas recovery for 1995 connections. These large reductions in gas recoveries per connection correlate with the diminishing gas supply response to increasing drilling activity.

To compensate for the trend in lower recovery per connection, an increasing number of wells has to be drilled to increase or even maintain overall natural gas production from the WCSB. Increasing drilling expenditures in higher productivity areas in the WCSB, or additional discoveries with high initial productivity similar to the Ladyfern project, would temper the number of wells and resulting connections required to increase deliverability.

The declining rate of production from existing connections has a significant impact on future deliverability. To offset this decline, production from one year's connections must amount to at least 85 million m^3/d (3 Bcf/d) in each year, or 20 percent of current production. For the past several years, it has taken an increasing drilling effort to accomplish this.

Based on its estimate of connections, the Board now projects that deliverability from the WCSB could decline to 450 million m^3/d (15.9 Bcf/d) by the end of 2004. This represents a four percent decrease or some 20 million m^3/d (0.7 Bcf/d) below the year end 2001 production rate. This projection is based on increasing drilling activity (resulting in 11,000, 11,500 and 12,000 gas well connections in 2002, 2003 and 2004 respectively) and on current producing characteristics determined from decline analysis; however, it does not consider the potential for large increments in deliverability from additional discoveries like Ladyfern.

GLOSSARY

Casing	Pipe which is cemented with well bore to isolate geological zones from one another.
Coal Bed Methane (CBM)	Methane gas produced from coal beds. Methane is the main hydrocarbon component of natural gas.
Completed Gas Well	A well which has normally tested gas, has casing in its well bore, is nearly ready to produce but has not been connected to a gathering and processing system.
Connection Year	The year in which a well is connected to a gas gathering and processing system and begins to produce.
Decline Rate	A term used to describe the decrease in production rate over time. It is usually expressed as a percentage per year. Most common forms are the nominal decline which is the slope of an exponential plot of production rate versus cumulative production. The effective decline is one less the ratio of the production rate at end of a given year to the production rate at the beginning of the same year.
Deliverability	The amount of natural gas a well, reservoir, storage reservoir, field or producing system can supply in a given period.
Gas Well	A well bore with one or more geological horizons capable of producing natural gas.
Gas Well Connection	A geological horizon for which natural gas production has been reported.
Marketable Gas	Natural gas which has been processed to remove impurities and natural gas liquids. It is ready for market use.
Reservoir	A porous and permeable underground rock containing accumulations of crude oil, natural gas and related substances that is confined by impermeable rock or water barriers.
Storage	Facility or reservoir used to accumulate natural gas during periods of low demand. It is used to deliver natural gas during periods of high demand.

Solution Gas	Natural gas that is dissolved in oil at reservoir conditions of pressure and temperature.
Successful Gas Well	Term used, in December 2000 *Short-term Natural Gas Deliverability EMA*, to represent the number of geological horizons producing at the end of a connection year.
Tight Gas	Natural gas contained in reservoirs where gas flow is restricted because rock grains are compacted tightly together.
Well Productivity	The amount of natural gas produced by a gas well, under normal producing conditions, over a given period of time. The rate is normally expressed as thousand cubic metres per day (mcf or MMcf per day).